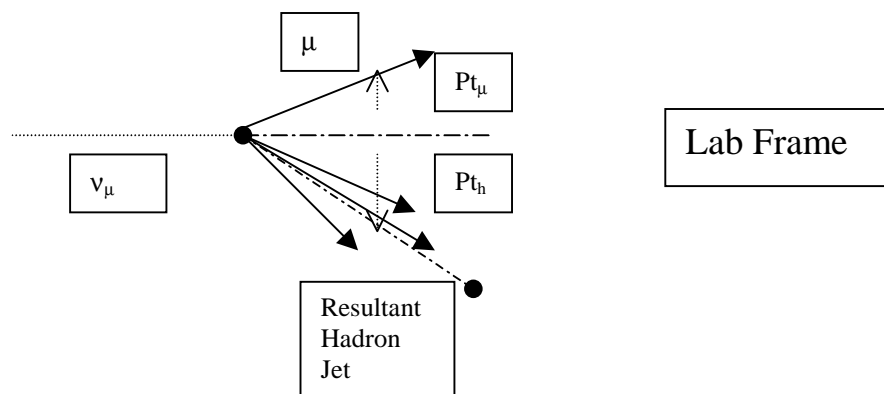


## Estimate of Total Neutrino Energy for (located) $\nu_\mu$ Events

► I've tried to come up with a method that uses the most accessible information we have to determine the energy of the interacting neutrino for located events:

- 1) Track angle information for all interaction daughter tracks from emulsion
- 2) Link of a emulsion track to reconstructed (momentum known) muon from spectrometer
- 3) Direction of the incoming neutrino (assuming it came from the dump!).
- 4) Employ conservation of momentum

► The basic idea is the following:



$$P(\nu)_\mu \sim P(\mu) + P_{t\mu}/\Theta_h$$

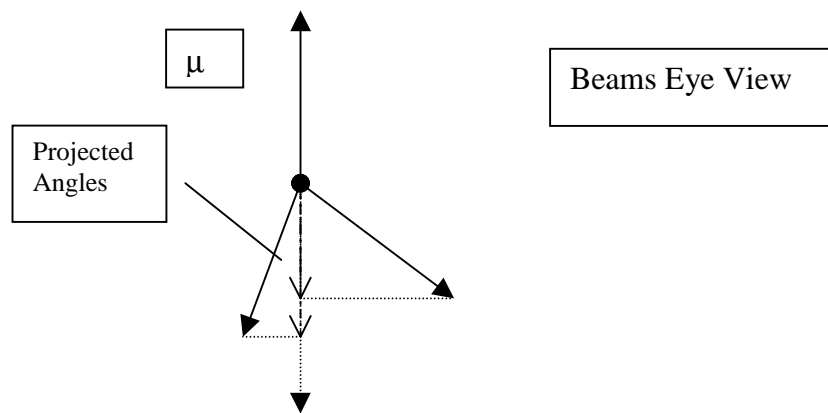
where  $P_{t\mu} = P_{t_h} = P_h \cdot \Theta_h$  from conservation of momentum

► The only unknown is  $\Theta_h$  - an estimate can be obtained from the remaining found emulsion tracks.

► A MC study was preformed to determine how well we can measure  $P(\nu)_\mu$

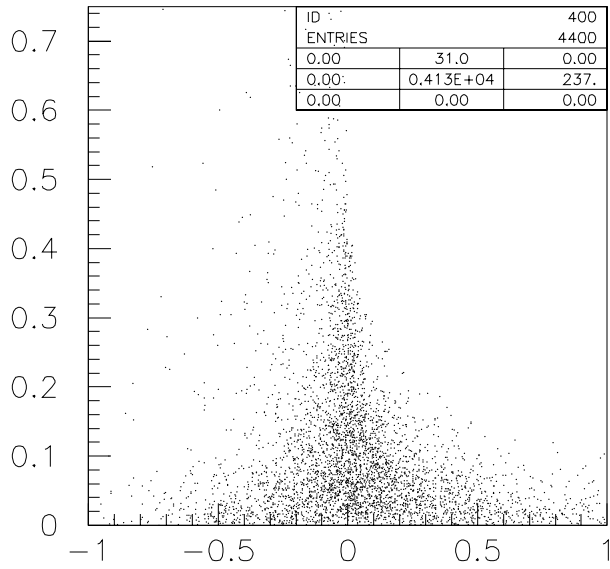
► Only  $\nu_\mu$  CC LUND interactions were generated (5000 events). I assumed at this point that we linked the muon track of known momentum to a measured emulsion track and all we know of the other tracks is there measured direction. I only use charged pions, kaons and protons.

- 1) For the pions, kaons and protons, I take a weighted average of the angle for these tracks.
- 2) The weight is equal to  $1/\Theta_{\text{hadron}}$
- 3) I weight only the projected angle (along beam direction: z) of the tracks  $180^\circ$  from the direction of the muon in beams view:

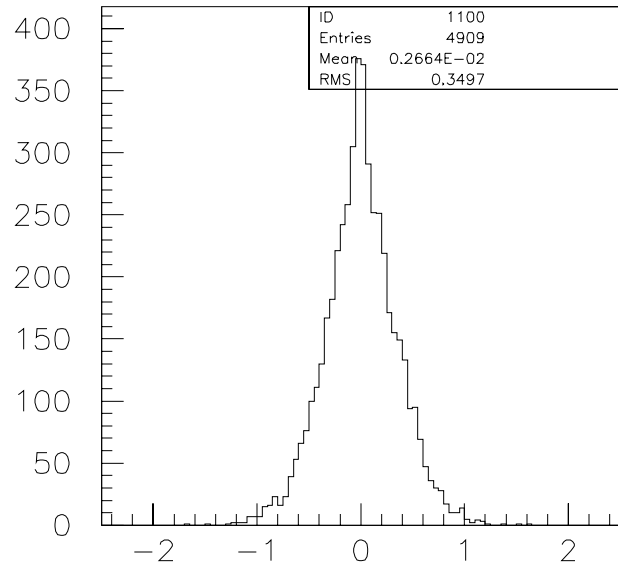


► Included below are some plots:

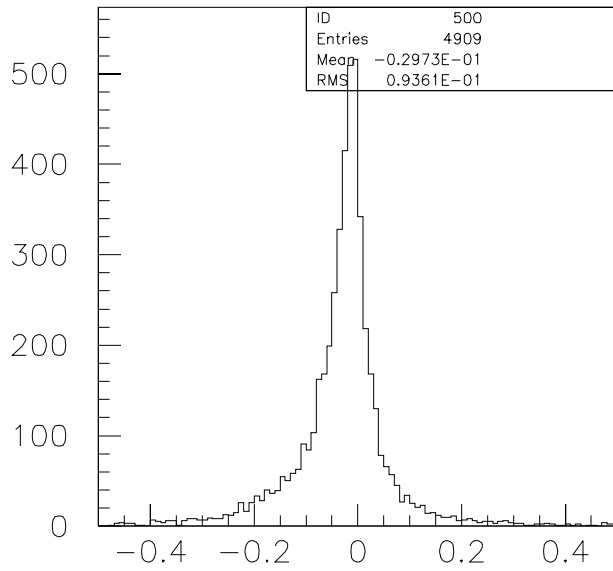
- 1) % error for estimated neutrino energy vs calculated angle for resultant hadron direction
- 2) Pt imbalance along opposite direction of muon in the azimuth
- 3) Angle difference between calculated resultant hadron direction and W direction
- 4) % error for estimated neutrino energy (corrected for offset in previous plot: 13mr)
- 5) Generated Neutrino Spectrum
- 6) Estimated Neutrino Energy using above method
- 7) Spectrum of neutrino CC events that I am unable to make an estimate for:  
No hadron tracks with  $>1$  mr angle in lab ( $\sim 10\%$  of the events)



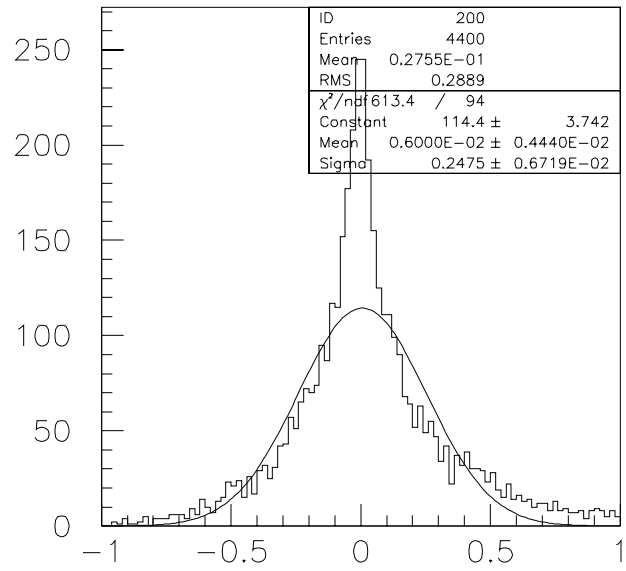
nu est - nu real / nu real vs angle



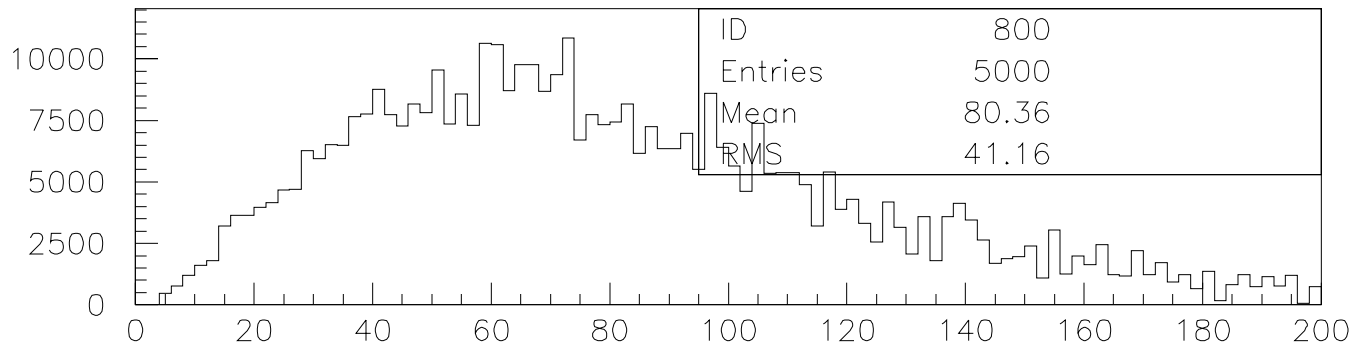
Pt imbalance - azimuth



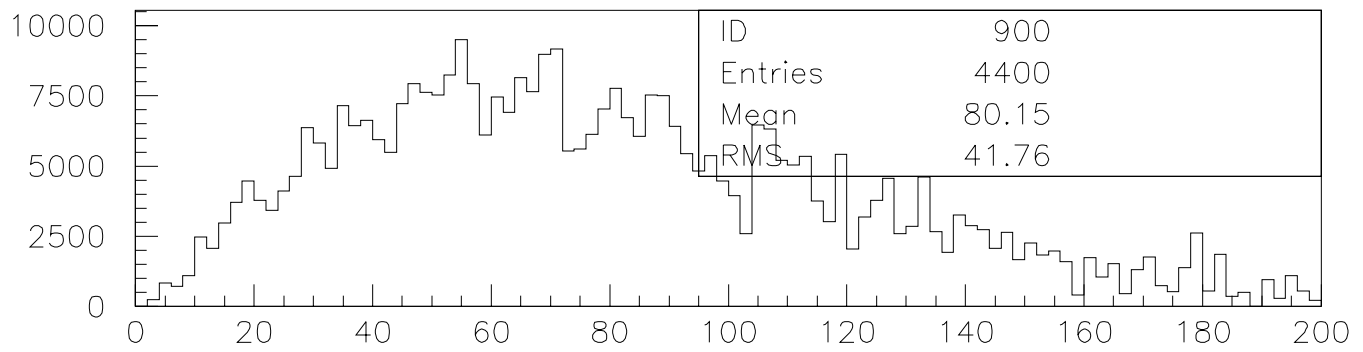
Angle Diff hads - W



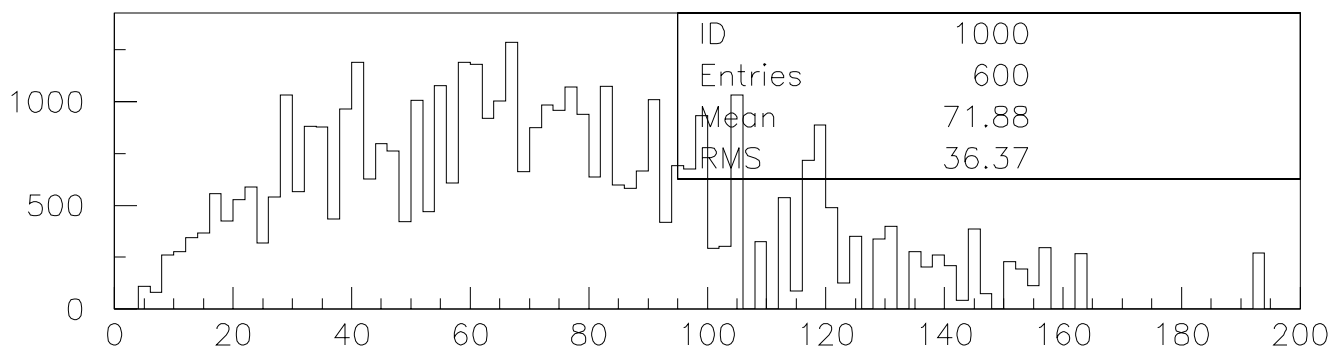
nu est - nu real / nu real



Real Neutrino Spectrum



Estimated Neutrino Spectrum



Lost Neutrino Spectrum